

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA25 | Castle Bromwich and Bromford

Water resources assessment (WR-002-025)

Water resources

November 2013

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA25 | Castle Bromwich and Bromford

Water resources assessment (WR-002-025)

Water resources

November 2013



Department
for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

A report prepared for High Speed Two (HS2) Limited.

High Speed Two (HS2) Limited,
Eland House,
Bressenden Place,
London SW1E 5DU

Details of how to obtain further copies are available from HS2 Ltd.

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.hs2.org.uk

High Speed Two (HS2) Limited has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the HS2 website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact High Speed Two (HS2) Limited.



Printed in Great Britain on paper
containing at least 75% recycled fibre.

Appendix WR-002-025

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Water resources assessment	002
Community forum area:	Castle Bromwich and Bromford	025

Contents

1	Introduction	1
1.1	Structure of the water resources and flood risk assessment appendices	1
1.2	Study area	1
2	Stakeholder engagement	3
3	Baseline data	4
3.1	General	4
3.2	Surface water features	4
3.3	Groundwater	10
3.4	Groundwater/surface water interaction	11
3.5	Water dependent habitats	13
4	Site specific assessments	14
4.1	Surface water	14
4.2	Groundwater	20
4.3	Detailed assessment	29
5	References	35

List of tables

Table 1: Surface water features within 500m of the route in CFA 25.	5
Table 2: Surface water discharge consents	8
Table 3: Licensed groundwater abstractions	11
Table 4 : Groundwater/surface water interaction	12
Table 5: Description of water dependent habitats	13
Table 6: Summary of potential impacts to surface water	15
Table 7: Summary of potential impacts to groundwater, WFD status, abstractions, GWDTE and groundwater/ surface water interactions	21

List of Figures

Figure 1: Conceptual hydrogeological model used to investigate potential groundwater effects due to the tunnel portals	33
------------------------------------------------------------------------------------------------------------------------	----

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 The water resources and flood risk assessment appendices comprise three parts. The first of these is a route-wide appendix (Appendix WR-001-025).
- 1.1.2 Two specific appendices for each community forum area (CFA) are also provided. For the Castle Bromwich and Bromford area (CFA25), these are:
- a water resources assessment (i.e. this appendix);
 - a flood risk assessment (Appendix WR-003-025);
 - a hydraulic modelling report for the River Tame (Appendix WR-004-019); and
 - a groundwater modelling report for the Bromford tunnel portals (Appendix WR-004-020).
- 1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5 water resources map book.

1.2 Study area

- 1.2.1 The study area for this CFA is Castle Bromwich and Bromford. This area covers a section of the Proposed Scheme approximately 5.1 km long. The area is predominantly urban in character, but its eastern end lies on the rural fringe. The rural and open area around the B4118 Birmingham Road and Park Hall nature reserve are located in this eastern section, with the rest of the area generally dominated by light industrial and commercial or infrastructure uses through Castle Vale, Castle Bromwich and Bromford. The commercial/industrial areas make use of the River Tame valley and also the infrastructure corridor that follows the valley. The main residential areas are generally on higher ground, away from the valley bottom, although Bromford is close to the Proposed Scheme.
- 1.2.2 The River Tame valley running through this area has become a major transport corridor into Birmingham City Centre, with the Birmingham and Derby line, running broadly from the east and into Birmingham New Street Station. The M6, A452 and A47 Fort Parkway are the major roads using this east-west corridor. Consequently, there are a number of locally important public highway crossing points of this corridor (starting from the east) comprising: B4118 Birmingham Road, A452 Chester Road and A4040 Bromford Lane.

- 1.2.3 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this spatial scope is defined as the study area.
- 1.2.4 The main environmental features of relevance to water resources and flood risk include:
- River Tame, Plants Brook and Dunlop Channel and their associated floodplains;
 -
 - the Permeable Superficial and Arden Sandstones Secondary A aquifers;
 - the Mercia Mudstone Secondary B aquifer;
 - three springs arising from the Mercia Mudstone group;
 - two groundwater dependent terrestrial ecosystems (GWDTEs) within 500m of the Proposed Scheme - Park Hall nature reserve and Castle Bromwich Local Wildlife Site (LWS); and
 - three abstraction permits from the Bromsgrove Sandstones Principal aquifer, this aquifer is not identified as a groundwater receptor due to its depth.
- 1.2.5 Key environmental aspects relating to water resources and flood risk include:
- realignment of the River Tame within Park Hall nature reserve;
 - extension of Plants Brook channel to pass under the route;
 - realignment of the Dunlop Channel to pass under the route;
 - construction activities taking place within the floodplain;
 - the construction activities taking place within the floodplain;
 - the potential impact on groundwater flow including springs; and
 - the potential impact on groundwater flow to local private abstractions.

2 Stakeholder engagement

2.1.1 Contact and discussion with the following stakeholders has been undertaken to inform the water resources assessment.

- the Environment Agency and the Birmingham and the Black Country Wildlife Trust (BBCWT) with regard to the proposed realignment of the River Tame within the Park Hall nature reserve, discussions with the Environment Agency regarding the modelling of river flooding and flood risk aspects; and
- Birmingham City Council (BCC) and Severn Trent Water Ltd (STW) with regard to surface water and drainage in the study area and to identify any private groundwater abstractions.

3 Baseline data

3.1 General

- 3.1.1 The following section provides a current description of water resources including surface water and groundwater.

3.2 Surface water features

- 3.2.1 All surface water features within 500m of the route are presented in Table 1. The current surface water baseline is shown on Map WR-01-042 (Volume 5). All surface water features are based on the Environment Agency's Digital River network.
- 3.2.2 All water bodies in this area fall within the Tame, Anker and Mease sub-catchment of the Humber River Basin District (RBD) and associated river basin management plan (RBMP).
- 3.2.3 The River Tame is the most significant watercourse in the West Midlands conurbation and drains a total catchment of 1500km² before discharging into the River Trent at Alrewas. The River Tame catchment upstream of Park Hall nature reserve is approximately 402km². The majority of the catchment is heavily urbanised and the channel has been extensively modified for a large proportion of its length. It is classed as main river, and as such, its management and regulation is the responsibility of the Environment Agency.
- 3.2.4 The descriptive values ascribed to surface water receptors in Table 1 below have been derived in accordance with the Scope and Methodology Report (SMR), Volume 5: Appendix CT-001-000/1, and its addendum, Volume 5: Appendix CT-001-000/2.

Appendix WR-002-025

Table 1: Surface water features within 500m of the route in CFA 25.

Water feature	Location description	Classification ¹	Water Framework Directive (WFD) water body and overall status	WFD status objective (by 2027 ² as per river basin management plan (RBMP)	Receptor value ³	Q95 (m ³ /s)	Catchment/s	Size (km ²)	Notes
River Tame: from confluence of two arms to River Blythe.	Flows eastwards parallel to, before crossing under, the Birmingham and Derby line.	Main river Heavily modified	Moderate GB104028046840	Good potential	High	2.074	Tame Anker and Mease	402	Catchment upstream of Park Hall nature reserve. Q95 estimate calculated for the River Tame in the Bromford Area.
Plants Brook: tributary of River Tame.	Approximately 80m north of the route, west of Value Stadium Football Ground.	Main river Heavily modified	Moderate GB104028046860	Good potential	High	N/A	Tame Anker and Mease	N/A	Will cross under the route in Park Hall area.
Dunlop Channel.	Located south of the Fort Industrial Park, and north of the Birmingham and Derby line, this channel will cross under the route.	Ordinary watercourse	No status shown in RBMP – assumed status. Moderate	No status shown in RBMP – assumed status. Good potential	High	N/A	Tame Anker and Mease	N/A	Runs along the River Tame in the Bromford Area. Receives flood waters from catchment.

¹ Environment Agency water-feature classification: The Land Drainage Act 1991 defines an Ordinary watercourse as 'A watercourse that is not part of a main river, all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages through which water flows'. 'Main Rivers' are larger rivers and streams designated by DEFRA, main rivers are regulated by the Environment Agency.

² Year may vary in different RBMPs.

³ For examples of receptor value see Table 43 in the Scope and Methodology Report (SMR) Addendum, Volume 5 Appendix CT-001-000/2.

Appendix WR-002-025

Water feature	Location description	Classification ¹	Water Framework Directive (WFD) water body and overall status	WFD status objective (by 2027 ² as per river basin management plan (RBMP)	Receptor value ³	Q95 (m ³ /s)	Catchment/s	Size (km ²)	Notes
Pond	Crossed by the Proposed Scheme at approximately 450m north-east of Parkhill Wood.	Not applicable	Not applicable	Not applicable	Moderate	N/A	Tame Anker and Mease	N/A	Linked to the River Tame by a drain.
Pond	Approximately 320m west of Parkhill Wood and 70m north of the route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Isolated field pond with no links to watercourses in the catchment.
Pond	Approximately 550m east of Parkhill Wood and 40m south of the route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Isolated field pond with no links to watercourses in the catchment.
Pond	Approximately 570m east of Parkhill Wood and 40m north of route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Isolated field pond with no links to watercourses in the catchment.
Pond	Approximately 330m south of Cameronian Hall which is approximately 30m from the route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Isolated field pond with no links to watercourses in the catchment.

Appendix WR-002-025

Water feature	Location description	Classification ¹	Water Framework Directive (WFD) water body and overall status	WFD status objective (by 2027 ² as per river basin management plan (RBMP))	Receptor value ³	Q95 (m ³ /s)	Catchment/s	Size (km ²)	Notes
Pond	Approximately 330 south of Cameronian Hall which is approximately 30m from route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Isolated field pond with no links to watercourses in the catchment.
Drain	Approximately 400m south of the refuse disposal works; and 600m south of the route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Appears to be isolated within Castle Bromwich Hall gardens.
Drain	North of Parkhall Wood; and approximately 120m south of the route.	Not applicable	Not applicable	Not applicable	Low	N/A	Tame Anker and Mease	N/A	Links to ponds in Park Hall nature reserve.

3.2.5 There are no licensed surface water abstractions within 500m of the Proposed Scheme within this study area.

3.2.6 Table 2 summarises surface water discharge consents within 500m of the route.

Table 2: Surface water discharge consents

Permit identifier	Distance from route (m)	Discharge type	Receiving water body
CT/10/01395/O 2	Approximately 70m north of the route, near Dunlop Channel.	Sewerage and other matter discharge - sewerage and surface water.	River Tame
T/10/36441/O	Aproximately 60 north of the route near Dunlop Channel.	Public sewage: storm sewage overflow.	Dunlop Channel
Tsc3210	Approximately 40m north at Dunlop Channel.	Sewage discharge - pumping station - water company.	Dunlop Channel
T/10/10062/T	Approximately 290m south of the route.	Trade effluent discharge-site drainage	River Tame
CT/10/10249/T 1	Approximately 90m south of the route.	Site drainage	River Tame
T/10/22101/O	Approximately 5m south of the route near pumping station.	Public sewage: storm sewage overflow	River Tame
Tsc1717	Approximately 80m north of the route at Plants Brook.	Public sewage: storm sewage overflow	Plants Brook

Appendix WR-002-025

Permit identifier	Distance from route (m)	Discharge type	Receiving water body
T/10/10249/T/2	Approximately 140m south of the route.	Trade effluent discharge-surface water	River Tame
T/10/22951/O/1	Approximately 150m north of the route at Plants Brook	Sewage effluent	Plants Brook
T/10/22777/O	Approximately 280m north of the route.	Public sewage: storm sewage overflow	River Tame
T/10/35431/R	Approximately 10m south of the route near pumping Station.	Sewage discharges - final/treated effluent - Water Company	River Tame
Tsc1443	Approximately 210m north of the route at Plants Brook.	Public sewage: storm sewage overflow	Plants Brook
T/10/21462/O	Approximately 60m north of the route near pumping station.	Public sewage: storm sewage overflow	Dunlop Channel
T/10/35406/O	Approximately 75m north of the route at Dunlop Channel.	Sewage discharges - pumping station - water company	Dunlop Channel
T/10/30195/O	Approximately 60m north of the route at Dunlop Channe.l	Public sewage: storm sewage overflow	Dunlop Channel

3.3 Groundwater

- 3.3.1 The study area mostly encompasses developed urban and semi-urban areas. Made ground was identified in most available borehole records and is expected to have been derived locally from land raising, as part of general development, as well as highway and railway infrastructure in the area.
- 3.3.2 Superficial alluvium generally overlays glacial deposits from around the Park Hall nature reserve to the western end of the study area. The thickness of this layer varies, but locally it can be up to around 6m. In addition, there are areas of river terrace deposits present on the northern side of the River Tame Valley near Park Hall nature reserve and Castle Bromwich Business Park. These deposits also extend to Bromford between the A452 Chester Road and south of the Fort Shopping Centre.
- 3.3.3 The superficial glacial deposits form a discontinuous covering over the solid geology and beneath made ground across the upper parts of the River Tame Valley sides. Most of the glacial deposits beneath the study area are sands and gravels, which are extensive but not continuous. The geological map indicates glaciofluvial deposits to be present at the start of the study area at Park Hall Wood and again to the south of the Birmingham and Derby line within Park Hall nature reserve, Castle Bromwich Business Park and west of the A452 Chester Road.
- 3.3.4 The Mercia Mudstone Group underlies much of the area. The Mercia Mudstone Group typically comprises weak red brown silty mudstone, with minor amounts of carbonate and gypsum when unweathered. The Arden Sandstone Formation occurs within the Mercia Mudstone as a thin horizon of siltstone and sandstone and when unweathered is a medium strong rock. The Arden Sandstone Formation is not mapped as outcropping at the surface in the study area, although British Geological Survey (BGS) borehole records have identified it at about 20m depth at the western end of the study area.
- 3.3.5 At its eastern limits, the study area crosses the southern side of the River Tame Valley, which is a steep topographical feature (15-20m high). The geology in this area (approximately 3.8km west of the B4118 Birmingham Road along the route to directly south of the existing Birmingham and Derby line at the River Tame crossing point comprises Triassic Mercia Mudstone with bands of dolomitic sandstone and siltstone (skerries), overlain by a thin covering of glacial deposits (sand and gravel). The occurrence of the more weathering resistant skerry bands is partly responsible for this topographic feature. Head deposits exist at the base of this feature.
- 3.3.6 Three categories of aquifer have been identified within the study area. The alluvium, river terrace deposits and glaciofluvial deposits are Secondary A aquifers, the Mercia Mudstone is a Secondary B aquifer, and the head is classed as a secondary undifferentiated aquifer. The Arden Sandstone within the Mercia Mudstone is classed as a Secondary A aquifer.

- 3.3.7 Groundwater is expected to be shallow and present within the superficial deposits across this study area. The Mercia Mudstone Group is water-bearing in places by virtue of the siltstones and sandstones of the skerries and the Arden Sandstones. Map WR-02-025 (Volume 5) indicates the spatial distribution of the uppermost superficial and bedrock formations within CFA25.
- 3.3.8 There are no groundwater source protection zones (SPZ) located within the study area.
- 3.3.9 Groundwater resources for the survey area are discussed in more detail in Volume 2, CFA Report 25, Castle Bromwich and Bromford (CFA Report 25), Section 13, Water resources and flood risk assessment.
- 3.3.10 Table 3: Licensed groundwater abstractions within 1km of the route.

Table 3: Licensed groundwater abstractions

Permit identifier	Distance from route (m)	Abstraction horizon	Max annual abstraction quantity (m ³ /year)	Max daily abstraction quantity (m ³ /d)	Number of boreholes
03/28/10/0008 (Jaguar Cars)	510m	Bromsgrove Sandstones	Unknown	Unknown	2
03/28/10/0033 (Fort Dunlop)	540m	Bromsgrove Sandstones	Unknown	Unknown	Unknown
03/28/10/0036 (Land at Washwood Heath)	680m	Bromsgrove Sandstones	Unknown	Unknown	2

- 3.3.11 There are no groundwater discharge consents within 1km of the route.

3.4 Groundwater/surface water interaction

- 3.4.1 Table 4 summarises groundwater/surface water interactions within 1km of the route.

Appendix WR-002-025

Table 4 : Groundwater/surface water interaction

Location description	Distance from route (m)	Formation	Elevation (mAOD)	Comments
River Tame	Immediate vicinity of the route.	Permeable superficial deposits	79.8	Site specific information on dependence is not available. The river has a more natural profile towards the eastern part of the area with an assumed connection with groundwater through the permeable superficial deposits. Further pre-construction assessment required.
Park Hall nature reserve	Immediate vicinity of the route.	Permeable superficial deposits	79-101	As above
Spring located south of The Fort	230m north of the route.	Mercia Mudstone Formation	82.5	No identified geological reason
Spring at works at Water Orton	190m north of the route.	Alluvium over Mercia Mudstone	82.5	No identified geological reason
Spring in parkland in Bromford Area	190m south of the route.	Mercia Mudstone Formation	86	Close to the Dickens Heath Fault

3.5 Water dependent habitats

3.5.1 Table 5: Description of water dependent habitats summarises the water dependent habitats within 1km of the route.

3.5.2 The table identifies where a water dependency exists. However, the assessment of the impact on water dependent ecology receptors is found in CFA Report 25, Section 7, Ecology.

Table 5: Description of water dependent habitats

Location	Distance	Designation	Comments
Park Hall nature reserve	Immediate vicinity of the Proposed Scheme	Ancient wetland semi-natural woodland habitats	The River Tame flows through the nature reserve. Site specific information on water dependence is not available. However, proximity to the River Tame and character of the superficial geology leads to an assumed connection though permeable superficial deposits. Further pre-construction assessment is required.
Castle Bromwich Wetland	540m	Marshy grassland habitats	Site specific information on dependence is not available. Assumed connection though permeable superficial deposits. Further pre-construction assessment is required.

4 Site specific assessments

4.1 Surface water

- 4.1.1 Table 6 summarises the potential impacts and effects to surface water features from the Proposed Scheme in this area. Only those effects that are classed as significant are presented in CFA report 25, Section 13.4.
- 4.1.2 Table 6 includes water features which could potentially be impacted by the Proposed Scheme. Features such as isolated ponds and drains which lie outside the area of impact of the Proposed Scheme are not included. However, details of the features are provided in Table 1. Where the ecology of water features is impacted these are assessed and presented within the Ecology Assessment in CFA Report 25, Section 7, Ecology.

Table 6: Summary of potential impacts to surface water

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and significance of effect	Other mitigation measures	Residual effect	Duration of effect
River Tame, Dunlop Channel and Plants Brook	High	rail and associated infrastructure	Potential impacts on water quality from runoff of water containing sediments/oil/fuel/concrete wash water from construction areas.	Minor adverse (Significant)	Draft Code of Construction Practice (CoCP) (see Volume 5: Appendix CT-003-000/1) section 16 regarding control of site drainage from earthworks and construction sites, and procedures to follow BS6031 Code of Practice for Earthworks ³ . Together with those paragraphs detailed below.	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary

³ BS 6031-2009 Code of Practice for Earthworks.

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and significance of effect	Other mitigation measures	Residual effect	Duration of effect
River Tame	High	Viaduct crossing the River Tame (to include deep cutting (Water Orton Cutting), initial embankment (Parkhall Wood embankment) , park hall access road, River Tame viaduct and retaining structure (Park Hall retained cut)).	Potential impacts on water quality from runoff water containing sediments/oil/fuel/concrete wash water from construction areas.	Minor adverse (Significant)	Draft CoCP section 16 'provision of a suitable construction site drainage system including cut-off ditches or drains and sustainable drainage systems, or equivalent, with suitably sized treatment facilities such as settlement or detention basins'; 'appropriate measures such as the use of bunds of non-erodible material or silt or sediment fences adjacent to watercourses'; and 'the good working practices detailed in the Environment Agency's Pollution Prevention Guidelines will be adopted', Temporary construction methods and CIRIA publications (including C532, C648 and C649).	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and significance of effect	Other mitigation measures	Residual effect	Duration of effect
		River Tame realignment.	Reduction of water quality through construction activities. Potential for high suspended solids.	Minor adverse (Significant)	Draft CoCP section 16 'the good working practices detailed in the Environment Agency's Pollution Prevention Guidelines will be adopted', Temporary construction methods and CIRIA publications (including C532, C648 and C649).	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary
		River Tame realignment.	Potential for in-channel capacity reduction through uncontrolled releases of sediment and materials into watercourses.	Minor adverse (Significant)	Draft CoCP paragraphs 16.3 to 16 state that construction activities will be undertaken having regard to the requirements to avoid increasing flood risk. This will include preparation of site specific flood risk management plans for those areas of the site at risk of flooding.	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and significance of effect	Other mitigation measures	Residual effect	Duration of effect
		Bromford tunnel and Bromford tunnel east portal, including Castle Bromwich retained cut and bored tunnel.	Reduction of water quality through construction activities. Potential for high suspended solids and poor quality groundwater from dewatering.	Minor adverse (Significant)	Measures as detailed in the draft CoCP paragraphs 16 outlined above. In addition CoCP paragraph 16.2 'HS2 Ltd will require its contractors to undertake risk assessments associated with excavation works and dewatering impacts on surface water, groundwater and abstractions'.	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary
Dunlop Channel	High	Plants Brook underbridge and Dunlop carrier channel culvert.	Reduction of water quality through construction activities. Potential for high suspended solids and poor quality groundwater from dewatering.	Minor adverse (Significant)	Draft CoCP paragraph 16 as outlined above for realignment of River Tame and viaduct crossing of the River Tame.	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and significance of effect	Other mitigation measures	Residual effect	Duration of effect
Plants Brook	High	Plants Brook underbridge and extension of Dunlop carrier channel culvert under Proposed Scheme.	Reduction of water quality through construction activities. Potential for high suspended solids and poor quality groundwater from dewatering.	Minor adverse (Significant)	As above	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary
River Tame floodplain	High	Construction phase activities within flood plain	Potential for increased flood risk by inadvertently displacing floodwaters.	Minor adverse (Significant)	Draft CoCP section 16 states that construction activities will be undertaken having regard to the requirements to avoid increasing flood risk. This will include preparation of site specific flood risk management plans for those areas of the site at risk of flooding.	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction temporary

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and significance of effect	Other mitigation measures	Residual effect	Duration of effect
River Tame	High	Routine drainage from track infrastructure	Potential for reduction in water quality from track drainage.	Minor adverse (Significant)	Balancing ponds located adjacent to the Plants Brook, the Dunlop Channel and the River Tame. These discharge to the River Tame and will improve quality of track drainage water.	Negligible impact Neutral Effect (not significant)	None required	Negligible impact Neutral Effect (not significant)	Construction permanent

CIRIA C532 (2001), Control of water pollution at construction sites; Construction Industry Research and Information Association

CIRIA C648 (2006), Control of water pollution from linear construction projects; Construction Industry Research and Information Association.

CIRIA C649 (2006), Control of water pollution from linear construction projects: Site Guide; Construction Industry Research and Information Association.

4.2 Groundwater

4.2.1 Only those impacts and effects that are classed as significant are presented in CFA report 25, Section 13.4.

Appendix WR-002-025

Table 7: Summary of potential impacts to groundwater, WFD status, abstractions, GWDTE and groundwater/ surface water interactions

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
River Tame	High	Cutting at Park Hall (Water Orton cutting).	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Significant)	Draft CoCP Section 16 concerning waste water and groundwater best practice measures, Remove or breakthrough cut-off structures following construction, incorporate passive bypasses within the design, incorporate collars in these passive bypasses to avoid creating artificial flow paths, implement a regime of post construction monitoring of groundwater levels.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Cutting (Castle Bromwich retained cut) for the Bromford tunnel east portal and 'cut and cover'.	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Significant)	Draft CoCP Section 16, as above	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
		'Dig out and replace' areas underneath embankment.	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
		All below ground construction sites and structures.	Barriers of low permeability affecting groundwater levels and quality.	Minor adverse (Significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		River Tame realignment.	Temporary dewatering to lower groundwater quality, levels and contributions to the watercourse.	Negligible (Significant)	N/A	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
Park Hall GWDTE	Moderate	Cutting at Park Hall (Water Orton cutting).	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
		'Dig out and replace' areas underneath embankment.	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		All below ground construction sites and structures.	Barriers of low permeability affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
Secondary aquifers (superficial deposits, Mercia Mudstones and Arden Sandstones)	Moderate	Cutting (Castle Bromwich retained cut) for the Bromford tunnel east portal and 'cut and cover'.	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
		Cutting at Park Hall (Water Orton cutting).	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		'Dig out and replace' areas underneath embankment.	Temporary dewatering affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
		All below ground construction sites and structures.	Barriers of low permeability affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary
Park Hall GWDTE and Castle Bromwich GWDTE	Moderate	River Tame realignment.	Temporary dewatering to lower groundwater quality, levels and contributions to the watercourse.	Negligible (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction temporary

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
River Tame	High	Cutting at Park Hall (Water Orton cutting).	Permanent groundwater controls affecting groundwater levels and quality.	Minor adverse (Significant)	Remove or breakthrough cut-off structures following construction, incorporate passive bypasses within the design, incorporate collars in these passive bypasses to avoid creating artificial flow paths, implement a regime of post construction monitoring of groundwater levels.	Negligible impact Neutral effect (Not significant)	Post-construction monitoring	Negligible impact Neutral effect (Not significant)	Construction permanent
		Cutting (Castle Bromwich retained cut) for the Bromford tunnel east portal and 'cut and cover'.	Permanent groundwater controls affecting groundwater levels and quality.	Minor adverse (Significant)	As above	Negligible impact Neutral effect (Not significant)	Post-construction monitoring	Negligible impact Neutral effect (Not significant)	Construction permanent

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		All permanent below ground structures extending into the saturated zone.	Barriers of low permeability affecting groundwater levels and flow.	Minor adverse (Significant)	As above	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction permanent
Park Hall GWDTE	Moderate	Cutting at Park Hall (Water Orton cutting).	Permanent groundwater controls affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	Post-construction monitoring	Negligible impact Neutral effect (Not significant)	Construction permanent
		All permanent below ground structures extending into the saturated zone.	Barriers of low permeability affecting groundwater levels and flow.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction permanent

Appendix WR-002-025

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Secondary aquifers (superficial deposits, Mercia Mudstones and Arden Sandstones)	Moderate	Cutting at Park Hall (Water Orton cutting).	Permanent groundwater controls affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	Post-construction monitoring	Negligible impact Neutral effect (Not significant)	Construction permanent
		Cutting (Castle Bromwich retained cut) for the Bromford tunnel east portal and 'cut and cover'.	Permanent groundwater controls affecting groundwater levels and quality.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	Post-construction monitoring	Negligible impact Neutral effect (Not significant)	Construction permanent
		All permanent below ground structures extending into the saturated zone.	Barriers of low permeability affecting groundwater levels and flow.	Minor adverse (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	Post-construction monitoring	Negligible impact Neutral effect (Not significant)	Construction permanent

Water feature / receptor	Value of water feature	Design element	Potential impact to water receptor	Magnitude of potential impact (no mitigation)	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Castle Bromwich GWDTE	Moderate	All permanent below ground structures extending into the saturated zone.	Barriers of low permeability affecting groundwater levels and flow.	Negligible (Not significant)	Draft CoCP Section 16, concerning waste water and groundwater best practice measures.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction permanent

4.3 Detailed assessment

4.3.1 Table 7: Summary of potential impacts to groundwater, WFD status, abstractions, GWDTE and groundwater/ surface water interactions summarises the excavations (cuttings and areas of dig out and replace) and requirements for groundwater control. The assessment is based on the excavation encountering groundwater based on water strikes noted on British Geological Survey borehole logs.

Appendix WR-002-025

Table 8: Summary of excavations and requirement for groundwater control

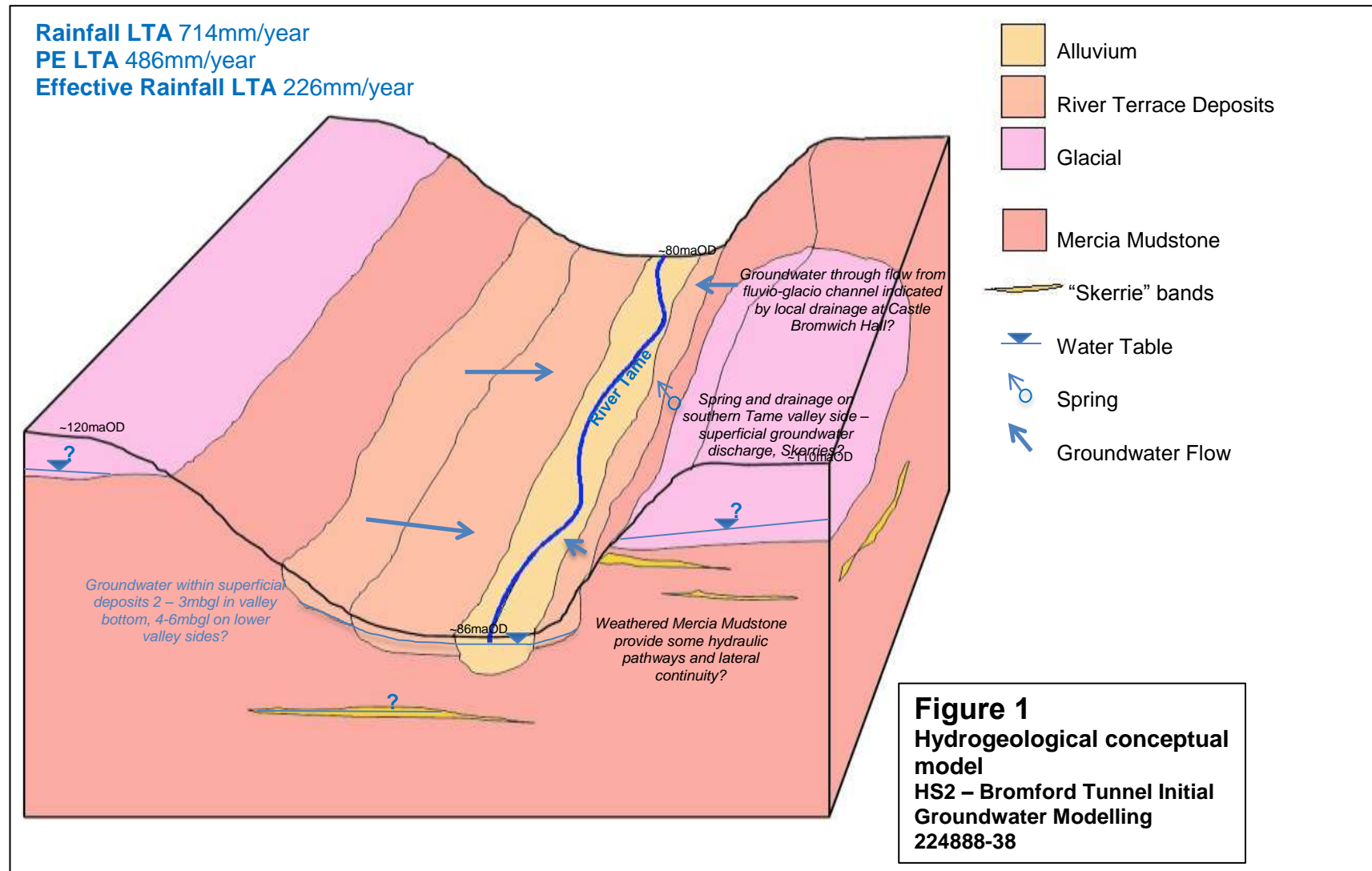
Cutting name and depth	Geology penetrated	Groundwater elevation	Potential impact on groundwater resources	Mitigation measures	Residual Significance
Park Hall	Alluvium over Mercia Mudstone Formation.	Cutting below water table	Interception of Alluvium/ Mercia Mudstone groundwater.	Pre-construction investigations to confirm requirement. If required, mitigation includes temporary and permanent groundwater control.	Not significant
Areas of dig out and replace under embankment	River terrace deposits over Mercia Mudstone Formation.	Cutting below water table	Interception of River Terrace Deposit/ Mercia Mudstone groundwater.	Pre-construction investigations to confirm requirement. If required, mitigation includes temporary and permanent groundwater control.	Not significant
Eastern portal retained cutting and cut and cover	Alluvium/ River terrace deposits over Mercia Mudstone Formation.	Cutting below water table	Interception of Alluvium/ River Terrace Deposit/ Mercia Mudstone groundwater.	Pre-construction investigations to confirm requirement. If required, mitigation includes temporary and permanent groundwater control.	Not significant
Bromford tunnel	Alluvium/ River terrace deposits over Mercia Mudstone Formation.	Tunnel below water table	TBM construction in low permeable Mercia Mudstone. No impact on groundwater resources.	Not required.	Not significant

Groundwater assessment of tunnel portal

- 4.3.2 There is a potential impact on groundwater flow to the River Tame from the construction of the eastern and western portals associated with the Bromford Tunnel, where the portals pass through the Secondary aquifer superficial deposits, potentially cutting off groundwater flow to the River Tame.
- 4.3.3 A conceptual model of the local geology and likely flow pathways has been developed based on geological information, mapping and the environmental baseline. This conceptual model has been used to construct a preliminary 3D numerical model using Visual MODFLOW to better understand the likely changes that may arise following the construction of the tunnel portal. The details of the groundwater modelling are presented in Volume 5: Appendix WR-004-020 - Groundwater modelling report for the Bromford tunnel portals.
- 4.3.4 The conceptual model was based on the following:
- 4.3.5 The superficial deposits have been categorised into the following strata and associated thicknesses based on BGS borehole records and 1:10,000 superficial geology map.
- first river terrace deposits, 3m thick;
 - second river terrace deposits, 4m thick;
 - glaciofluvial deposits, ranging between 4m – 15m thick; and
 - alluvium, 6m thick.
- 4.3.6 All of these deposits are generally described as being free draining sands and gravels. The underlying bedrock of the Mercia Mudstone is expected to be weathered in its upper 10-15m, the glacial and alluvial materials deposited and infilling hollows within the bedrock. Siltstone and sandstone 'skerry' bands occur in places and are thought to occur on the southern side of the River Tame valley in the area of the steep "cliff".
- 4.3.7 In terms of hydrogeology, the glacial and fluvial superficial deposits are all considered Secondary A aquifers and generally described as sand and gravel materials which are considered permeable (permeability 1×10^{-6} m/s).

- 4.3.8 The underlying Mercia Mudstone is a Secondary B aquifer, although generally much less permeable than the overlying superficial deposits (permeability $1 \times 10^{-9} \text{m/s}$). The Mercia Mudstone is expected to be weathered in its upper 10 – 15m and include more permeable siltstone/sandstone “skerry” bands in places which can be water bearing.
- 4.3.9 Groundwater within the valley bottom is expected to be shallow adjacent to the river, 1 – 3m below ground level, and at greater depth on the valley sides. Groundwater flow within the superficial deposits is expected to follow the topography. Springs and density of local drainage on the southern valley side may indicate shallow groundwater flow to the north into the River Tame valley from the river terrace and glaciofluvial deposits and possibly “skerry” bands.
- 4.3.10 The long term average rainfall for the area is approximately 714mm/year, and the potential evaporation is approximately 486mm/year, meaning an effective rainfall of approximately 226mm/year. The largely urban catchment with areas of hard standing will mean that there will be a significant component of run-off reducing infiltration recharge.
- 4.3.11 The River Tame is the main drainage feature, which is embanked and a modified channel in places, but is assumed to generally be in continuity with groundwater. The Environment Agency gauging station downstream at Water Orton has a Baseflow Index (BFI) of 0.50, indicating that a significant proportion of the baseflow to the river is comprised of groundwater flow.
- 4.3.12 Figure 1, illustrates these features in the form of a sketch of the conceptual hydrogeological model. This conceptual model has been used to formulate the structure for a numerical model which has been used to simulate likely groundwater flows and levels in the vicinity of the tunnel portal.

Figure 1: Conceptual hydrogeological model used to investigate potential groundwater effects due to the tunnel portals



- 4.3.13 A two layer 3D calibrated numerical model was constructed. The model was run in transient mode for a period of one year. Calibration was undertaken by systematically altering model properties and boundary conditions to obtain a best fit between the modelled groundwater levels and observed groundwater levels, or water strikes. The calibrated model was subsequently used to predict the impact on groundwater levels by the presence of the portals.
- 4.3.14 The results from the modelling have identified the potential for the eastern and western portals to act as barriers to groundwater flow with localised increases in groundwater levels on the up-hydraulic gradient side of the portals, and decreases in groundwater levels on the down-hydraulic side of the portals. This will potentially result in a moderate adverse impact and a significant effect on groundwater flow to the River Tame.
- 4.3.15 The effect of decreasing groundwater flow to the River Tame in the areas of the eastern and western portals could be mitigated by a variety of measures such as the inclusion of a passive bypass for groundwater control. The exact form of mitigation will be determined following pre-construction investigations, including a regime of groundwater monitoring, and more detailed groundwater modelling. Following the implementation of appropriate mitigation, it is considered that this will result in no significant effect.
- 4.3.16 Additionally, the implementation of a regime of post-construction monitoring of groundwater level will verify the success of the mitigation measures.

5 References

British Geological Survey (2000), Geology of the Birmingham area – Memoir for 1:50,000 Geological Sheet 168 (England and Wales); British Geological Survey.

British Geological Survey; GeoIndex; <http://www.bgs.ac.uk/geoindex/>; Accessed: 2013.

British Geological Survey (2000), The physical properties of minor aquifers in England and Wales; British Geological Survey.

British Geological Survey (1987), Geology of the country around Warwickshire - Memoir for 1:50,000 geological sheet 184 (England and Wales); British Geological Survey.

Burkhardt, M., Rossi, L., and Boller, M. (2008), Diffuse release of environmental hazards by railways; Desalination 226, 106-133.

Centre for Ecology and Hydrology; National River Flow Archive; http://www.ceh.ac.uk/data/nrfa/data/time_series.html?28102; Accessed February 2013.

CIRIA C643 (2005), The potential for water pollution from railways, Construction Industry Research and Information Association.

CIRIA C532 (2001), Control of water pollution at construction sites; Construction Industry Research and Information Association.

CIRIA C648 (2006), Control of water pollution from linear construction projects; Construction Industry Research and Information Association.

CIRIA C649 (2006), Control of water pollution from linear construction projects: Site Guide; Construction Industry Research and Information Association.

Ellis, P. A. (2002), The impact of urban groundwater upon surface water quality: Birmingham – River Tame study, UK; The University of Birmingham.

Environment Agency; What's in my backyard; <http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopicsandlang=e>; Accessed: July 2012.

Environment Agency (2009), River Basin Management Plan Humber River Basin District; Environment Agency.

Environment Agency (2007), Pollution Prevention Guideline 5: Works in, near or liable to affect watercourses; Environment Agency.

Knipe, C.V., Lloyd, J.W., Lerner, D.N. and Greswell, R. (1993), Rising Groundwater levels in Birmingham and the engineering implications, CIRIA Special Publication.

Natural England; http://www.english-nature.org.uk/citation/citation_photo/1001772.pdf; Accessed 2012.

The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010.